Chapter 6.25

Sp3 Model 655 Series

HFCVD Diamond Deposition Reactor

(sp3) (595)

1.0 Equipment Purpose

1.1 The Sp3 model 655 series hot filament CVD (HFCVD) diamond deposition reactor produces thin film polycrystalline diamond coatings on 4" and 6" Si wafers. The hot filament technology allows deposition of high quality nano-crystalline (NCD) and microcrystalline (MCD) poly-diamond films with controllable grain size uniformly over large areas and multiple wafers.

2.0 Manual Scope

2.1 This manual describes the operational procedures and user level trouble shooting guides of the Sp3 HFCVD diamond deposition reactor system. Please refer to the vendor equipment manual (hard copy in the Nanolab office) for facilities requirements and maintenance issues.

3.0 Applicable Documents

3.1 4.1 Sp3 Hot Filament Diamond Deposition Reactor User Manual (Sp3® document)

3.2 4.2 Sp3 Hot Filament Diamond Deposition Reactor Service Manual (Sp3® document)

3.3 4.3 Material Safety Data Sheets for the following materials: H_2, CH_4, N_2, TMB

4.0 Definitions & Process Terminology

4.1 HFCVD: Hot filament CVD, the technique that uses an array of W filament wires that gets carburized in a heated methane environment to form a resistive heating element to provide energy required for the diamond deposition reaction uniformly over a large area.

4.2 MCD: Micro-crystalline diamond, with ~1μm grain size.

4.3 NCD: Nano-crystalline diamond, with ~0.1μm grain size.

4.4 Typical Source Materials:

4.4.1 TMB : Trimethylboron, $B(CH_3)_3$ is used for in-situ doping of diamond films.

4.4.2 CH_4 : Methane, carbon source for diamond deposition.

4.4.3 H_2 : Dissociates into atomic H at high temperature, and plays an important role in maintaining the desired diamond tetrahedral sp3 configuration that gives high quality diamond over the undesired sp2 configuration, which is simply graphite.

4.5 Substrate Material

4.5.1 Sp3 is configured to deposit poly-diamond simultaneously over four 6" or nine 4" wafers, with two types of trays available for each wafer size. Standard Si wafers supplied by the Nanolab or other vendors can be processed in the tool, with further material stack restrictions explained in sections 8.1 and 9.2.1.

4.6 Available Film Types

4.6.1 The tool is capable of depositing both MCD and NCD films, however only the MCD film type has been repeatedly deposited and well characterized as of now. Therefore, the current recipe available to users is for depositing MCD films. Characterization of MCD films took precedence because they are known to give lower damping loss for MEMS resonators. Characterization of the NCD process is in progress and will be released once process staff tests the NCD recipe given by the OEM.

4.7 Temperature Control

4.7.1 Substrate temperature heavily affects the growth rate, grain size and film quality. For MCD films, the optimum deposition temperature is between 700°C-720°C, and is set to be 720°C for the current tool setup. The substrate temperature is sensed by a thermocouple that contacts the wafer from the backside. The temperature is primarily a function of the filament temperature, the distance between the wafer and the filament, and thermal conductivity of the cooling stack under the wafers. Gas flow rates and process pressure also plays a role in determining the substrate temperature.

4.7.2 Filament temperature

4.7.3 The heater filament operates at 1950°C, and its temperature is monitored by a fixed position 2-color pyrometer. The W wires that form the heating filament turn into tungsten carbide as the heater temperature is ramped up in the methane atmosphere, and exhibits a very nonlinear I-V curve. The resistivity, and thus the heat radiation characteristics of the filament depends heavily on this carburization process, and other minor details such as the type and vendor of the W wire used. For process stability and repeatability purposes, the filament carburization steps and temperature adheres to the OEM developed recipe and is fixed.

4.7.4 Cooling stack & wafer-filament distance

4.7.5 The temperature control in the tool is open loop. It is primarily controlled by the thermal conductivity of the cooling stack under the wafers that transfers the heat away from the wafers, and also sets the distance between the wafers and the heating filament as given by the difference between the fixed distance between the filament wires and the base of the deposition chambers and total height of the cooling stack materials.

4.7.6 The cooling stack consists of a group of machined plates of varying thickness made of different materials, such as graphite, aluminum, copper. It also uses quartz washers and spacers to create air gaps to induce higher thermal resistivity than a solid would where needed in the stack, yet the gap"s thermal resistivity is a function of process pressure and gas flow rate. This variation of material types and thicknesses allow variation of the substrate temperature, however it is achieved in discrete steps rather than in a continuous fashion due to the limited number of cooling plate combinations.

4.7.7 720°C is set to be the optimum tool operating temperature. The fabrication of a set of cooling plates with finer thickness steps that will allow finer control of temperature is in progress and will be characterized and installed by process staff. The current cooling stack should never be tampered with, and any processes that require a different deposition temperature should be discussed with process staff.

5.0 Safety

5.1 High Temperature

5.1.1 The chamber lid, cooling stack, heating filament and its holder gets very hot during deposition and should be handled only after they cool down to room temperature.

5.2 High Voltage

5.2.1 This tool uses high voltage electrical power in various subsystems such as the filament power supply. User should never open the power supply enclosures and panels located around the tool.

5.3 Emergency Stop Button

5.3.1 The emergency off (EMO) push-button switch is located on the main control panel next to the user interface screen in the event that the reactor must be powered down quickly, and should only be used for emergency situations. This switch will disconnect all primary power to the reactor in the system AC distribution cabinet. It will interrupt any process that is in operation at the time it is pushed. To reactivate the system the EMO switch must be pulled forward before restoring system power, which should be done by the equipment staff.

6.0 Process Data

6.1

7.0 Available Processes, Gases, Process Notes

7.1 Sp3 accepts four 6” or nine 4” Si wafers, with quartz wafer holders available for both wafer sizes. There cannot be empty slots in the wafer holder during deposition, because the empty areas would expose the graphite surface of the wafer cooling stack that would react with process gases and damage it. Therefore, all wafer slots must be filled with either process or dummy wafers.

7.2 Only the following materials are allowed in the tool without asking for explicit process review by process staff:

7.2.1 Films grown or deposited in the Nanolab furnaces: Si, SiGe, SiO_2, Si_3N_4 or silicon rich nitride, poly-Si, AlN.

7.3 Following materials are strictly forbidden in the tool:

7.4 Any exposed Nickel, Platinum, Cobalt, Iron are strictly off limits. These metals are catalysts for CNT growth, and will not only ruin your process but also severely contaminate the chamber.

7.4.1 No Gold and other highly diffusive metals such as Cu, Ag, since the wafers processed in Sp3 should be able to be further processed in non-MOS clean furnaces.

7.4.2 Photoresist will burn and contaminate the chamber and is not allowed.

7.5 Wafers that have metals anywhere in the process stack should be discussed with process staff first before getting processed in Sp3.

7.5.1 Buried Ni, Pt, Co and Fe films that are completely covered under another layer, e.g. oxide, can be considered for processing in Sp3 after process review and approval by process staff.

7.5.2 The MFC"s used in SP3 have the following values:
N_2 = 10,000 sccm
H_2 = 5,000 sccm
CH_4 = 200 sccm
TMB Lo = 25 sccm (calibrated as H_2)
TMB Hi = 50 sccm (calibrated as H_2)
The TMB concentration is 2.1%, balance H_2.

7.5.3 Other metal films, such as Ti, W, TiW, will probably carburize during deposition yet may not contaminate the chamber. Their presence should also be discussed with process staff.

7.6 Available Recipes

7.6.1 UCB1T35H: Standard MCD deposition recipe provided by the equipment manufacturer. This recipe deposits 2µm MCD diamond, with deposition time set to 35 hours (deposition rate = 9.5Å/min), temperature at 720°C and 1sccm TMB flow that gives ~10kΩ/square sheet resistance.

7.6.2 MCD_Var: Variable MCD deposition recipe that is an exact replica of UCB1T35H. Users are allowed to change the deposition time for controlling film thickness, and TMB flow rate for controlling conductivity.

7.6.3 Users are allowed to use only the recipes in the „User Recipes" folder, and only modify the variable recipes designated with the suffix „Var" in the recipe name.

7.6.4 Users should never modify the standard recipes in the User Recipes folder. These recipes are provided by the equipment manufacturer and are proven to work and produce high quality diamond films. They should be used as a template to modify the variable recipe as needed, primarily to change deposition time for thickness control and doping level.

7.6.5 Users should never attempt to change the OEM provided service recipes in folders other than the "User Recipes" folder.

8.0 Equipment Operation

8.1 Diamond deposition process consists of the following steps:

8.1.1 Wafer cleaning

8.1.2 Wafer seeding

8.1.3 Filament making

8.1.4 Filament loading

8.1.5 Wafer loading

8.1.6 Filament holder loading

8.1.7 Recipe setup

8.1.8 Recipe running

8.1.9 Unloading filament holder

8.1.10 Unloading wafers

8.1.11 Clean-up & Log out

8.2 Wafer cleaning

8.2.1 Sink8 piranha cleaning for wafers without any metal on them

8.2.2 svc-14 cleaning in msink1 for wafers with metal on them

8.2.3 Wafers must be properly cleaned before seeding them with diamond nanoparticles. This will ensure proper seeding and high quality film growth on your samples, as well as prevent accumulating contaminants in the seeding bath that will compromise everyone else"s processes.

8.3 Wafer seeding

8.3.1 Proper seeding of wafers is a critical part of the diamond coating process and any errors in this step will affect all the later steps.

8.3.2 The diamond seeding setup is located at Msink20 in the Nanolab.

8.3.3 Material Restrictions

8.3.3.1 The following materials are strictly not allowed in the diamond seeding bath, and will ruin the seeding solution:

8.3.3.2 Water – pay attention to not to drop any water into the solution. Wafers must be dry, as well.

8.3.3.3 Graphite – completely ruins the solution.

8.3.3.4 SiC - results the solution to take a dark color. For SiC substrates, a dedicated bath is needed. SiC should not be allowed in the general use bath.

8.3.3.5 Plastics - contaminates the solution. As such, the solution cannot be stored in a plastic bottle; it should be kept in glass beakers for seeding use and long term storage.

8.3.3.6 Diamond coated wafers – sp3 vendor had concerns on seeding already diamond coated wafers. It can possibly degrade the seeding solution. Any carbon rich film should be reviewed before being cleared to be used in the diamond seeding bath.

8.3.4 Wafer seeding process flow

8.3.4.1 Enable the ultrasonic bath, shown in Fig.1, from Mercury.

8.3.4.2 Enter the number of wafers you will seed, and their diameter in the comments section, e.g. 2x6” + 1x4”.

8.3.4.3 Keeping an accurate count of cumulative number of the wafers processes in the bath is very important, because the solution is good for a total of 200 6” wafers or 500 4” wafers, and needs to be replaced once this count is reached.

8.3.4.4 Check the water level in the ultrasonic bath tank. The water outside the beaker in the ultrasonic bath tank constantly evaporates; therefore add water to the ultrasonic bath tank until the level meets the 1500mL mark line of the graduated beaker that houses the diamond seeding bath, as shown in Fig.2.

8.3.4.5 Note: Take care to never add or spill water into the diamond seeding solution in the beaker during this process, as it will ruin the solution.

8.3.4.6 Check the methanol level in the diamond seeding solution beaker, which should read 3000mL. If the level is lower than 3000mL due to evaporation, then add more methanol to fill it up to 3000mL, but not more, as shown in Fig.2.

8.3.4.7 Run the ultrasonic bath for 10 minutes with no wafers in the seeding bath.

8.3.4.8 Take the aluminum foil lid with the Parafilm lining under it off the beaker.

8.3.4.9 Place a wafer on the carrier handle, as in Fig.3.

8.3.4.10 It is recommended to have a mouth cover or face shield on all the time during the wafer seeding process in order not to breathe over the wafers and to protect both the seeded wafers and the seeding solution.

8.3.4.11 Place the carrier handle in the seeding bath, as in Fig.4.

8.3.4.12 Run the ultrasonic bath for 5 minutes with the wafer in the solution.

8.3.4.13 It is possible to under-seed the wafers if you run the ultrasonic bath for less than 5 minutes. But, after 5 minutes the wafer surface saturates so over-seeding is not a concern.

8.3.4.14 Place the wafer onto the spinner, located to the left of Msink20 as shown in Fig.5.

8.3.4.15 Run spinner process G, set to 500 rpm for 10 seconds, followed by 1500 rpm for two minutes.

8.3.4.16 Wet the wafer with Methanol during the first 15 seconds of the spinner run from a squirt bottle as it spins.

8.3.4.17 Unload the wafer from spinner. Store securely to avoid contamination before loading to the diamond reactor.

8.3.4.18 Repeat until all the wafers are seeded.

8.3.4.19 Turn the ultrasonic shaker off.

8.3.4.20 Place the aluminum foil cap with the Parafilm lining under it back. Tightly seal the edges of the beaker to minimize evaporation. Replace the Parafilm layer and aluminum foil if it is torn up.

8.3.4.21 Disable the seeding setup.

8.4 Filament Making

8.4.1 There are two possible fixtures to string the filaments, Section 8.4.2 – 8.4.8 describes the method using the filament maker fixture, and the method using the filament threader is explained in the video which can be accessed by clicking on the icon in Figure 14.

8.4.2 Use of the filament maker fixture to facilitate this process is shown in Fig.6.

8.4.3 Bend loose end of wire from the spool over the metal fixture end to form a 90° bend at about 10mm from the tip of the wire.

8.4.4 Insert bent tip (as it will be inserted in the filament array assembly) into the outer hole in the filament maker bar.

8.4.5 Pull the filament wire tightly along the length of the filament maker bar to the end of the bar. Make sure there are no bent spots and kink along the wire, since such spots will

create high resistivity points and break the wire at high temperature and ruin your process.

8.4.6 Bend the uncut end to a 90° angle over the bar. Cut the bent end at about 10mm from the bend.

8.4.7 Place the finished filament in a „finished tray" to prevent damage and to minimize tangling. There are three empty trays provided for this purpose kept under the filament processing table next to Sp3. Do not place more than fifteen wires in one tray, as more wires will likely get tangled and ruined.

8.4.8 Repeat steps 9.3.1 through 9.3.5 for the minimum of 31 filaments required to fill the filament holder, as well as a few extras to replace any long, short or damaged filaments.

8.5 Filament Loading

8.5.1 Fasten the H-shaped holding fixture to the filament holder assembly with the four 3/8" nuts if it is not already in place, as shown in Fig.7.

8.5.2 Loosen the nuts holding the filament array assembly together with the 3/8" and place them in the provided plastic box.

8.5.3 Remove the top halves of the filament array assembly.

8.5.4 Shake out and clean any used out filament ends from previous runs. Wipe away any remaining diamond residue.

8.5.5 Insert and evenly space all 31 filaments into the array assembly.

8.5.6 Replace the top halves of the filament array assembly making certain the filaments are firmly seated. Replace any filaments that are too long, too short or damaged.

8.5.7 Tighten the nuts for the filament array assembly. Do not over tighten nuts, as they will crack due to thermal expansion at the elevated process temperature.

8.6 Wafer Loading

8.6.1 Enable Sp3.

8.6.2 Open the reactor lid. The reactor should look clean as in Fig.8, free of diamond flakes, broken filaments etc. that may remain from previous runs. Vacuum clean any particles and flakes.

8.6.3 Place the proper quartz wafer holder for 6" or 4" wafers, located in the shelf next to the tool. Align the four holes drilled on the wafer holder to the four quartz spokes that go through the cooling stack, as shown in Fig.9. Be careful in order not to crack the quartz tray or spokes as they can get brittle over time due to diamond accumulation.

8.6.4 Place wafers into the opening of the quartz wafer holder, placing all open positions with either process wafers or dummies.

8.7 Filament Holder Loading

8.7.1 Flip the filament array assembly (already prepared as described in section 9.5) around to face the wires down, holding it from the H-shaped holding fixture.

8.7.2 Align the two holes drilled at the edges of the filament array assembly to the two quartz supports in the CVD reactor. Slowly lower the filament array assembly as guided by the supports through the holes, as shown in Fig.10. Be careful as the quartz supports are fragile.

8.7.3 While holding the filament array with one hand, use your free hand to adjust and align the filament tensioner at the far end of the reactor to the smaller holes on the other side of the filament holder assembly, as shown in Fig.10.

8.7.4 Place the copper strap over the bolt on the one side.

8.7.5 Place and tighten the 5/8” nuts. Note: Two washers go on the side of the filament holder with the copper straps placed under and over it, and only one washer on the side with the tensioner fixture.

8.7.6 Remove the H-shaped holder assembly fixture.

8.7.7 This is a step that you can easily forget by mistake, and the results can be disastrous. The holder assembly is made of aluminum, and will short the current through the heating filaments, and will melt to leave a mess behind. Never run the reactor with the holder assembly still attached to the filament array.

8.7.8 WARNING: If there are any filaments that hang too loose and close to the wafers, please do not proceed until you replace the faulty filament. Loose or bent filaments will lead to small current flow and lower temperatures.

8.7.9 If the filament touches the tray and/or the wafers, it will melt over the tray and the wafer. Your wafer will crack and the quartz tray will be damaged. The filament wire can cause an arc and can damage the chamber walls. The complete run may abort, as well.

8.7.10 If the filament does not touch the wafers, yet is loose and closer to the wafers then the rest of the filaments, you will have thickness non-uniformity over that area.

8.7.11 Check and verify there are no faulty filaments, and you can now close the reactor lid and it is ready to run.

8.8 Recipe Setup

8.8.1 Click LOGIN

8.8.2 Enter your 4-digit user ID (given to you upon qualification) when prompted by the tool, and click Enter.

8.8.3 Note: Sharing user IDs with other lab members is prohibited.

8.8.4 You now have access to the GUI page that has main controls to run the tool, as shown in Fig.11. Click Menu, then Desktop.

8.8.5 Click „Recipe“ menu in the Desktop page, as shown in Fig.12.

8.8.6 The software will prompt you for the recipe folder. Users are only allowed to use the „User Recipes“ folder.

8.8.7 Select the recipe you would like to modify, e.g. „MCD_var“ for changing the deposition time, doping level etc.

8.8.8 Note: Users are only allowed to change the variable recipes, marked with the suffix „_Var“ in the file names. This prevents accidental changing of the standard baseline recipes, which users can use as a template to adjust the variable recipes for their needs.

8.8.9 Selecting the recipe and clicking Open will bring you to the recipe editing page, as shown in Fig.13. There are various steps in a recipe file, however only two of these steps are directly relevant to the film deposition, as will be discussed below. The remaining steps

perform auxiliary functions such as leak checking, temperature stabilization, chamber back filling etc.

8.8.10 The only two steps that the users need to change to control deposition parameters are step numbers 13 and 14, which are the „Deposit 1" and „Deposit 2" steps, respectively, as shown in Fig.13. Changing any other step will not be relevant to the film deposition and will only compromise the process by messing up the vendor specified parameters for basic functions such as leak checking and other process safety aspects, and therefore is prohibited.

8.8.11 Deposit 1 Step: Users are advised not to change the duration of this step, which is set to "01:30:45" in hr:min:sec format. This step uses a different filament current and voltage than the following „Deposit 2" step, because the tool is still in the process of carburizing the W filaments. The carburization process reaches steady state at the end of the ~90 min time period of this step.

8.8.12 The only parameter that will be of interest to the users, and also the only parameter they are allowed to change, is the TMB flow rate as set by „LoH2/TMB", as marked in Fig.13. This parameter sets the dopant gas concentration, and can be set to zero if the user wants an undoped film. The current setting of 1sccm is found to give reasonable conductivity and low acoustic damping loss for MEMS resonators. Users can experiment and adjust this parameter according to their process needs.

8.8.13 Deposit 2 Step: This step uses a higher filament voltage and current value, and forms the main part of the deposition process.

8.8.14 There are two parameters that the users are allowed to change at this step:

8.8.15 „LoH2/TMB": Sets the dopant gas flow rate, and should be set to the same value as in step „Deposit 1".

8.8.16 „Step Time": This is the setting that should be used to control film thickness. For example, the standard „UCB1T35H" recipe provided by the vendor gives a 2µm MCD film in 35 hours. If the one would like to deposit 1µm, then the required time is 17.5 hours. Since users are advised not to change the duration of „Deposit 1", the step time of „Deposit 2" should be set to "17.5-1.5=16" hours, i.e. 16:00:00 in the text box.

8.8.17 The standard recipes should cater to the majority of the users" needs. However, if your process requires different deposition conditions, then discuss them with the process staff and potentially the tool vendor to clear the feasibility and safety concerns.

8.8.18 Once recipe setup is complete click Verify, and make sure the software does not prompt any warnings after verification process.

8.8.19 Save your recipe under the „File > Save Recipe" menu.

8.8.20 Click „"File > Download Recipe" to download the adjusted and verified recipe to the reactor.

8.8.21 The software will prompt a confirmation message, click OK.

8.8.22 Click Done, which will bring you back to the Desktop page

8.9 Run Recipe

8.9.1 In the Desktop page, select “Control > use GUI” to arrive at the graphical user interface that will allow you run the recipe you loaded in the previous section.

8.9.2 Check that the recipe name under the “Current Recipe” display matches the recipe you loaded to the reactor in section 9.7.

8.9.3 Click Start.

8.9.4 The software will prompt a popup menu. Click Start again on this menu.

8.9.5 Click OK to the confirmation message.

8.9.6 The reactor status should now change to „RUN".

8.9.7 You can monitor the current step, remaining step time and total remaining time information from the header display at the GUI page.

8.10 Unloading Filament Holder

8.10.1 The machine should be in IDLE state, and the “Current Step” should display “0-/Standby” once your run is successfully complete.

8.10.2 Wait until the temperature reading of the thermocouple that monitors substrate temperature reaches 30°C, as displayed by the reading „Right" as shown in Fig.11.

8.10.3 Open the reactor lid.

8.10.4 Fasten the H-shaped holding fixture to the filament holder assembly with the four 3/8” nuts.

8.10.5 Loosen the three 5/8” nuts (two on the side with copper strap and one on the tensioner side) with the wrench.

8.10.6 Pull off the copper strap from the filament holder assembly.

8.10.7 Remove the entire filament holder assembly by slowly lifting it up by holding it from the H-shaped fixture. Be careful not to exert lateral pressure on the quartz support rods. Furthermore, the carburized filaments are very fragile, and will crumble over your wafers if you shake the fixture too much as you lift it up.

8.10.8 Take the filament holder over a trash can, and clean the used filaments away, which should break apart easily, and place it back over the filament preparation table.

8.11 Unloading Wafers

8.11.1 Take the quartz wafer holder tray out, slowly without cracking the tray or the quartz supports.

8.11.2 Take the wafers out with a tweezer.

8.12 Clean-up & Log out

8.12.1 Vacuum clean any diamond flakes, broken filament residue etc. in the reactor.

8.12.2 Close the reactor lid.

8.12.3 Log out from the tool.

8.12.4 Disable Sp3.

9.0 ***Troubleshooting Guidelines***

9.1 Process aborts with „low N_2 alarm"

9.1.1 There is no N_2 to the tool because it"s not enabled, or there is an issue with the house N_2 supply. Make sure the tool is enabled, and there are no general N_2 supply problems.

9.2 Wafer temperature is not between the 700°C-720°C band.

9.2.1 The most likely cause is a few broken filaments due to bad filament making. The tool will keep running even if up to three filaments break. Your run will complete, but at a lower temperature and thus at a lower deposition rate. You will observe thickness non-uniformity under the broken filament areas.

9.2.2 You can check the filament and wafer condition from the viewing port located at the front-right side of the reactor, where you can see if any filaments are broken or not. Caution: Always keep the lid of the viewing port closed when the reactor is running. Looking into the reactor as it runs without the filter on the lid of the viewing may hurt your eyes.

9.2.3 Temperature inconsistencies can be also due to hindered thermal conductivity between the backside of the wafer and the cooling stack due to excessive diamond accumulation over the cooling stack over time. Contact equipment staff for proper tool cleaning.

9.3 Run aborted before completion.

9.3.1 More than three filament wires broke during deposition.

9.4 Particles or shiny spots on random points across the diamond film.

9.4.1 The quartz wafer tray accumulates diamond and starts to generate flakes of varying size if it is not regularly cleaned. These particles will fall onto your wafers, especially when the tray goes under excessive stress due to expansion at high temperature and spits out the accumulated diamond flakes. Report this condition to staff if you notice a dirty tray and they will provide a clean tray if there is not one already in the wafer tray cabinet and clean the dirty ones.

9.5 There are finger prints and other marks on the wafer tray.

9.5.1 Always touch the reactor parts and the tray with clean gloves. Any residual organics on the gloves will lead to marks on the parts during diamond deposition.

10.0 Figures & Schematics

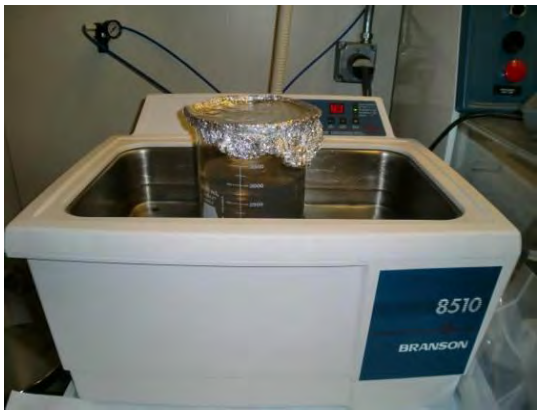

Fig.1: Diamond seeding setup

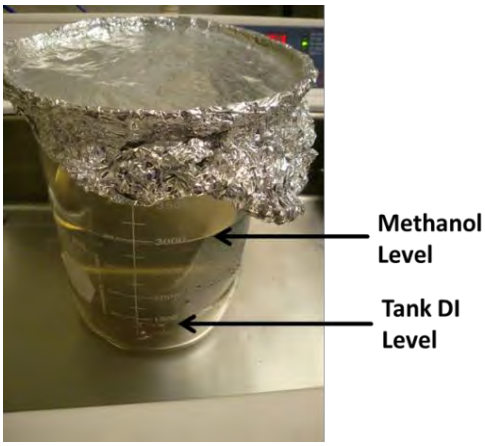

Fig.2: Liquid levels for methanol and DI

Fig.3: Wafer seeding carrier

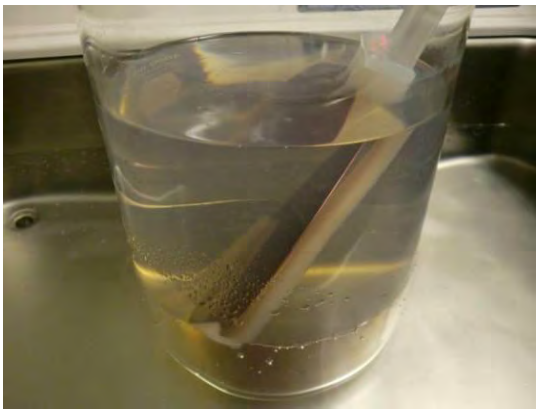

Fig.4: Wafer placed in seeding bath

Fig.5: Spinner dry after seeding bath

Fig.6: Filament maker fixture

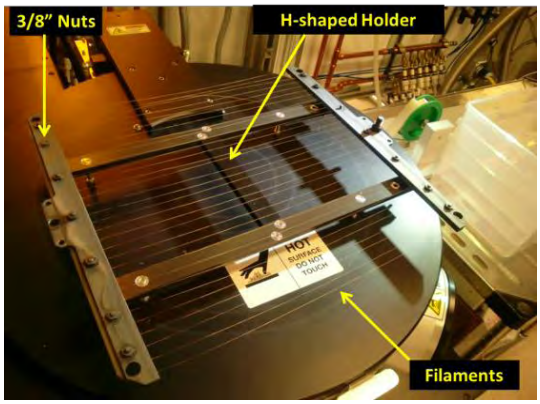

Fig.7: Filament array assembly

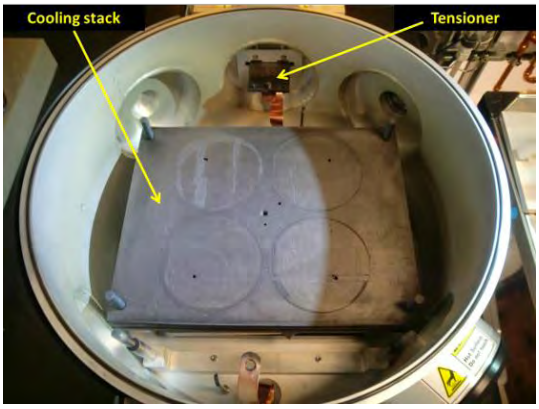

Fig.8: Reactor before wafer loading

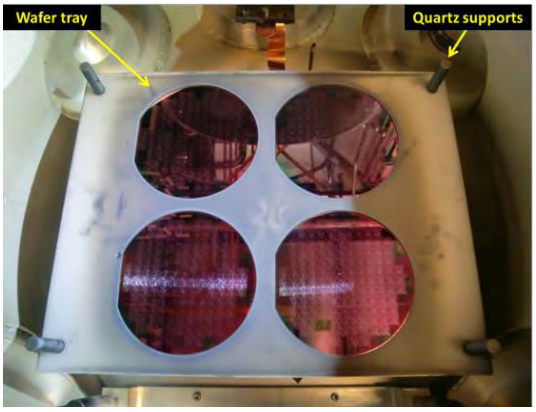

Fig.9: Wafer loading

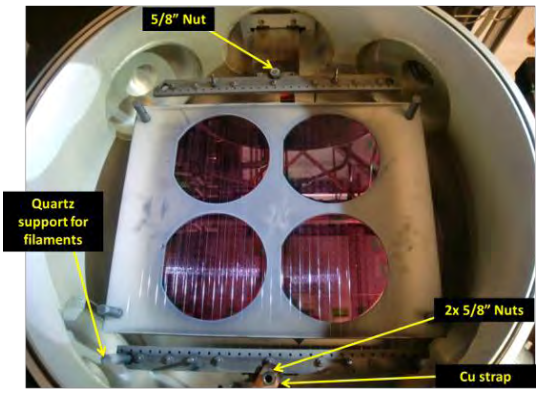

Fig.10: Properly completed reactor setup, ready for closing the lid and run the process.

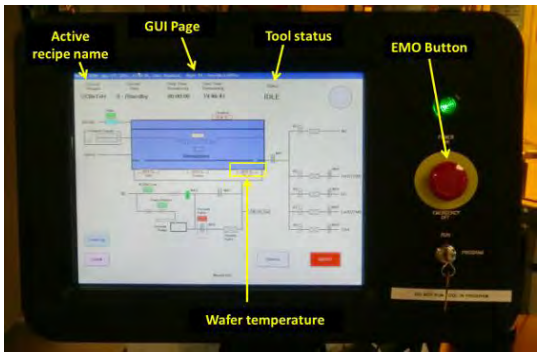

Fig.11: GUI Page

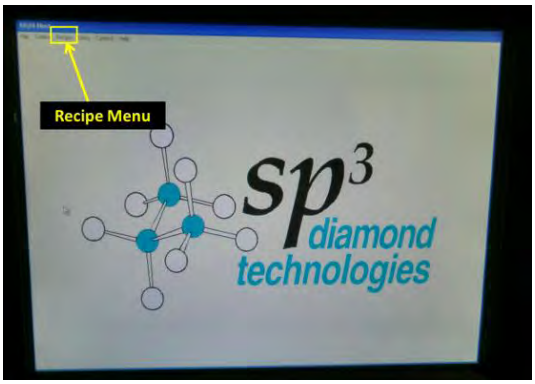

Fig.12: Desktop page

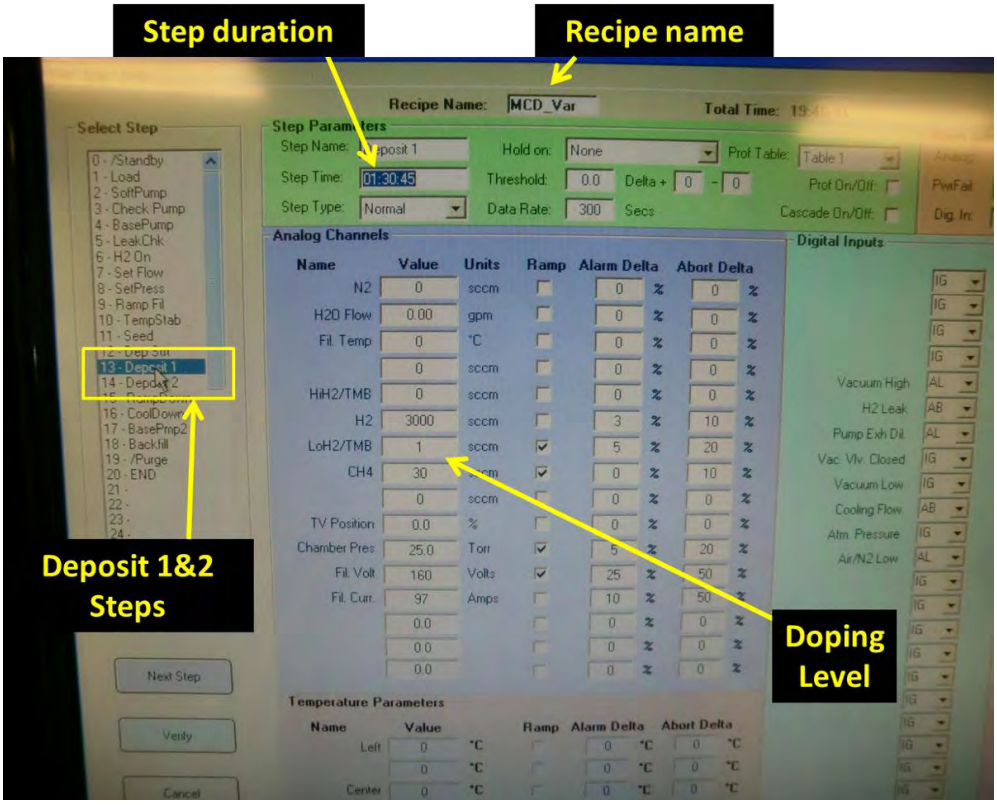

Fig.13: Recipe editor page

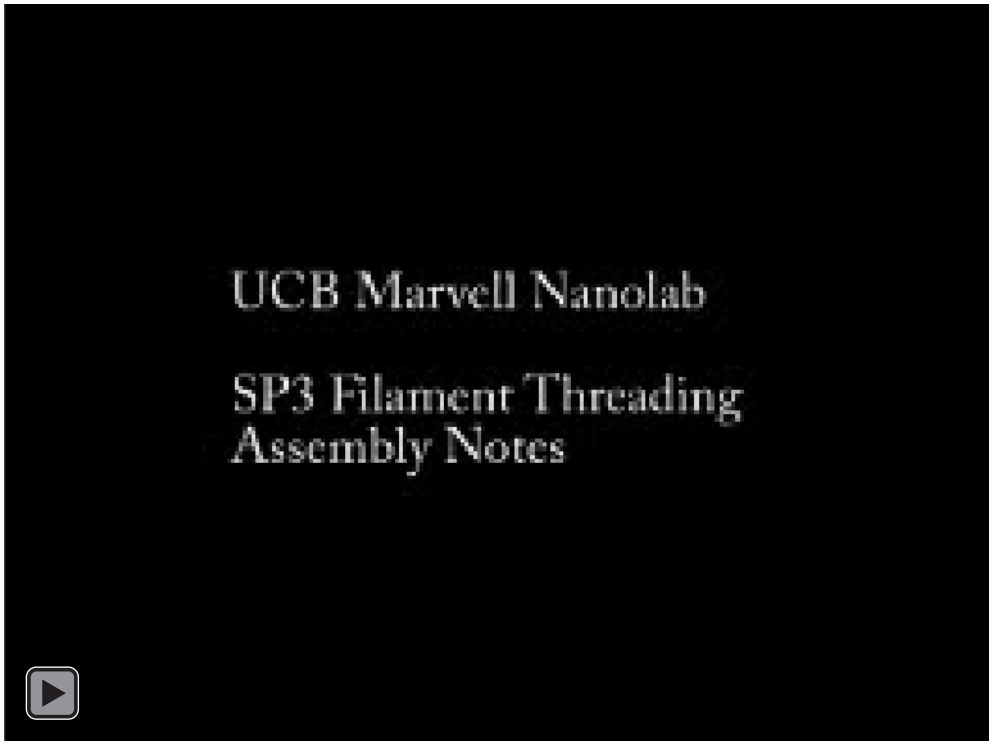

Fig. 14: Filament Threader video

11.0 Appendix A: Seeding solution prep guidelines (done once/year)

11.1 3000ml Methanol mixed with 45ml diamond seeding solution for today"s setup in a 3500 ml beaker.

11.1.1 The solution is sold in 15ml vials, with a 6 month shelf life (Part #8750101).

11.2 After mixing a fresh solution, and prior to each wafer seeding run, one should place the solution without any wafers in the ultrasonic bath for 10 minutes.

11.3 The solution should be kept at room temperature, both for storage and during seeding.

11.4 The solution temperature rises due to ultrasonic agitation during seeding. Therefore if you are successively seeding more than one wafer, then place ice cubes in the ultrasonic bath water, and supply more ice as it melts.

NanoLab Qualification Form

Sp3 Model 655 Series

HFCVD Diamond Deposition Reactor

(sp3) ***(595)***

Name _____ **Office** _____ **Date** _____

Campus Phone _____ **Home Phone** _____

Login _____ **Trainer** _____

Equipment Qualification Test Passed (Initial) _____

Oral Qualification Checklist

-

Superuser Login Name _____ Date _____

Superuser Signature_____